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THE EFFECT OF PARA-STIMULUS VERBAL INTERFERENCE ON SHORT-TERM VISUAL RETENTION

by

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The undersigned certify that they have read, and recommend to the Faculty of graduate Studies for acceptance, a thesis entitled "The Effect of Para-stimulus Verbal Interference on Short-term Visual Retention", submitted by George Ernest Bates in partial fulfilment of the requirements for the degree of Master of Arts.

Abstract

This experiment tested the hypothesis that short-term memory for visual stimuli can exist even in the absence of verbal encoding. Para-stimulus interference - vocal activities elicited from the S both prior to, during visual stimulus presentation and for a short period following stimulus removal - was compared with noninterference conditions on the retention of nonlinguistic, verbally nonclassifiable visual stimuli. One group of Ss was trained in a verbal set, another in a visual set. Stimulus duration was varied from .5 to 4 seconds. It was hypothesized that PSI conditions would not greatly inhibit recall and would cause an effective change from verbal to visual means of encoding the stimulus; that is, there would be no significant difference between scores from the two groups, giving support to the theory that encoding of visual stimuli can be nonverbal. Results showed substantial recall for the stimuli despite verbal interference measures taken. However, they appeared to be somewhat contradictory with regard to specific hypotheses.

Although verbal set scores were significantly higher than visual set scores this was considered more a result of familiarization bias. According to self-reported mental set both groups shifted to part visual, part mixed, and a few essentially verbal approaches. According to prediction there was no difference between the visual and partially verbal Ss. However, there

were strong indications that the few Ss who reported themselves to be strongly verbally oriented did significantly better on stimulus recall.

Verbal interference then was partially but not totally successful, and suggestions were given for future modification in experimental controls.

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George Ernest Bates

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Theories of Encoding in Visual Short-Term Memory

A number of recent authors in the field of short-term memory have claimed that visual STM is extremely brief (within a second or two) and visual stimuli can only be recalled after this period on the basis of having been verbally coded, (e.g., Mackworth, 1962, 1963a, Glanzer 1963, 1964). The intent of this thesis is to provide evidence that verbal encoding is not essential to certain visual STM tasks.

Attention has been given visual memory since the turn of the century mainly in an effort by nativist and associationist theorists to explain the changes over time which take place in the recall of visual forms. Memory over shorter intervals received its emphasis much later as an indication of memory capacity in the field of individual differences. Interest, however, in the phenomena and factors which limit short-term memory has grown more as a result of Hebb's proposed distinction between short-term and long-term memory in 1949.

Short-term memory (STM) has been defined by Melton (1963) as memory involving single trials over intervals up to five minutes, and is distinguished from learning by having as its domain the processes which take place during intertrial intervals. A number of variables, phenomena, and processes have received attention, some

of which are neural traces, proactive, retroactive, interserial and intraserial interference, masking, processing speed, encoding, association and familiarity, set, organization, rehearsal, stimulus qualities, and temporal relationships.

Both the fields of auditory and visual STM have been explored. In the latter, since the evidence (Sperling, 1960; Averbach and Coriell, 1961; Mackworth, 1959, 1962, 1963a; Smith and Carey, 1966) that post-stimulus visual images suffer rapid decay (from .25 to 2.5 seconds) an immediate need arose to explain the mechanism which permitted the later recall of a visual trace whose temporal duration was extremely limited.

Nearly all authors concur that two stages of STM exist. Their experimental conclusions are best summarized by Aaronson (1967) who describes the first stage as characterized by "unidentified sensations" or "direct representations" of the physical stimulus attributes (including the post-stimulus visual image) which are held in a large-capacity multiple channel buffer store, but suffer rapid decay with the passage of time and intervening events. Stage 2 involves processing at higher level, the items being identified or encoded on the basis of a "meaning or a name of some sort". Stage 2 is considered a limited-capacity, slow-decay system. Although representations are more permanent after stage 2 than during stage 1, only one item at a time can be handled by the system.

Haber (1965), Conrad (1962, 1964), Mackworth (1959, 1963a, 1963b, 1964a), Melton (1963), Wickelgren (1965), Hintzman (1965), and

McKinney (1966) all concur as to the importance, if not the necessity, of verbal encoding in this second stage of visual retention, but tend to allow for the possibility of a "nonlinguistic code", especially for nonlinguistic stimuli (Haber, 1966). Glanzer (1963, 1964), goes further and, in offering a "verbal loop" hypothesis, allows no leeway for other means of processing visual stimuli.

Although there are proponents of nonverbal STM (e.g., Neisser, 1967) few studies have been done to demonstrate the realm or usefulness of nonverbal methods in handling visual information. Furth's (1963) studies with deaf children led him to believe that verbal experience was not essential to the organization and memory of visual percepts. Factor analyses of intelligence test subtests scores also indicate a nonverbal component of mental functioning and memory (Davis, 1956).

It was this writers impression that there has been a lack of interest and possible control over the relevant variables in visual STM and that verbal encoding theories, although probably correct with regard to linguistic visual stimuli, are premature when applied to visual STM in general.

An experiment is presented as one approach to providing necessary controls.

Duration of the visual image (stimulus trace)

Because a subject (S) can report correctly only a limited number (7 $\pm$ 2, Miller, 1956) of items in his original visual store, Sperling (1960) employed a partial report method in order to determine

how many items the S could store originally. Instead of requiring that his Ss report on the whole of a complicated tachistoscopic presentation he had them report on only a part. A brief exposure of three rows of four randomly chosen letters (50 msec.) was given. After a variable delay a tonal signal (high, middle, or low frequency) was used to indicate which of the rows the S was to report on. Since the S could not predict which signal would be given, in effect he had to store the whole array. By this method Sperling was able to show that for a minimal delay (0.5 second or less) between exposure and recall, Ss has available information far in excess of the normal memory span. Accuracy declined rapidly as a function of time, and Sperling suggested that information can be stored as an actual "visual image" for only a fraction of a second after the visual stimulus has disappeared.

In a similar study Averbach and Coriell (1961) used a visual rather than auditory signal (to assure that the array and the signal were "transmitted" at the same rate). A television tachistoscope was used to present stimuli containing up to 16 letters. A pointer appeared above the letter to be reported. By correcting for "readout time" (time to detect the marker and read the significant letter) these authors estimated visual storage time to be from 250 to 300 msec.

Using a trials to criterion model to circumvent a "limited goal set", Smith and Carey (1966) had Ss report as many letters as they could from a previously designated row in a 6 by 6 array

of English consonant capitals. "Disrupted" conditions in which a 20 msec presentation was followed by a different 20 msec presentation at variable delay intervals were compared with "interrupted" conditions where the second presentation was identical with the first, and also with "continuous" conditions ranging up to 400 msec. The authors point up the coincidence that mean trials to criterion for a 20 msec presentation disrupted after 380 msec was identical with using a single undisrupted 20 msec presentation, and suggest from the general pattern of results that whereas sensory registration may be effectively complete within 20 msec, processing the information takes place at a much slower rate. The Ss apparently are able to process all the information they could get from a single presentation within about 380 msec from its onset.

In an early experiment by Jane Mackworth (1959), the results of visual search for labelled and unlabelled lights at different periods of delay showed the nonverbal cues to be more effective at short delays whereas at the longer delays the difference was in the opposite direction. Mackworth reasoned that at the longer delays visual cues become ineffective without some other reinforcement. In a detailed analysis of the time relations of the responses of a highly practiced female S shown sets of digits at 125 msec, Mackworth (1963a) found that at 1.5 secs the probability of identifying a digit correctly was 0.87. By 2.5 secs the probability was below 10% (chance).

Mackworth found that the rate of naming digits orally from a display was about 3.5 per second. Reasoning that if the rate of recognizing digits in the visual image was the same as the rate of naming them from the display, then the time taken to recognize the four digits out of a set of eight, which were normally recorded following a 62 msec exposure (Mackworth, 1962) indicates a visual image that must have lasted about 1.2 secs. On the same basis Mackworth (1963a) reinterpreted Sperlings results to show that the 1.3 secs required to report the usual four digits from the memory span, taken together with his 0.5 sec reaction time, gives a duration of the visual image of about 1.8 secs. From her several studies Mackworth concluded that the visual image is "a sensory representation of the retinal image and lasts not longer than about one or two seconds".

Erickson (1964) on the other hand, used a pattern of X's and O's in various combinations arranged around the face of an imaginary clock, and used as a follow-up stimulus an arrow pointing to one of these spots at various delay intervals. Using forced choice responses he points out that in none of his experiments was any evidence found of a "brief perceptual memory", and criticizes Sperling for ignoring the general problem of the latency of the perceptual response and the time the perception itself lasts. (Mackworth attempted to make a correction for this in her reinterpretation above, 1963a).

It can be seen that although the majority of experiments agree with the theory of a rapidly decaying visual trace there is not total agreement regarding the trace duration. Several authors suggest the limit to be in the range of 250 to 380 msec. Mackworth suggests it to be in the order of one to two seconds. This latter impression is reinforced by Averbach and Sperlings suggestion (1961, as reported by Smith and Carey, 1965) that under normal conditions the trace may in fact "decay over a period of several seconds". (All authors accept the visual trace as a separate phenomenon from the "after-image" in which the visual angle represented by the image remains constant).

<u>Verbal encoding hypothesis</u>

In further studies using briefly presented displays of digits, letters, colours, or shapes Mackworth (1963a, 1963b, 1964) discovered that the number of correctly reported items varied directly with the speed of recognizing and naming these various symbols - a higher number of digits recalled than shapes because digits are "recognized" and "read" quicker than shapes, the trace duration remaining constant in each case. Mackworth suggested that the memory trace goes through two different stages, the first being a "direct representation of the visual situation, of brief duration, and the second its translation into a more durable form, often verbal." The accrual of the verbal component which is required for durable retention depends on rehearsal. She further hypothesized that subject differences in recall of visual messages

can be explained in terms of individual interference differences affecting recognition.

From a different approach, Conrad (1962, 1964) found certain systematic errors in STM for certain visually presented letters of the alphabet, and noticed furthermore that the identification of the "partially decayed trace" was very similar to that of the aurally perceived stimulus masked by white noise. In other words, the letters most likely to be confused in STM are those which sound most alike. He concluded simply that most subjects in the memory situation repeated the letters sub-vocally.

Hintzman (1965) agreed that auditory coding as postulated by Conrad was one of the major processes in STM, but also hypothesized that various classification schemes should be available when meaningful stimuli are used. He selected five digits and five letters so that for each digit there was a letter with a similar sounding name (e.g., 2 and q, 3 and t). These were presented in mixed random order on a memory drum, one per second, and immediately after presentation of the eighth item S wrote down as much of the sequence as he could remember. During half the trials white noise was presented over headphones, the noise level being high enough so that S could not hear his own voice when speaking. Analysis of errors indicated that Ss adopted two possible coding strategies; digit vs. letter categorization - attempts to classify the symbol strings or make up mathematical formula, and rote subvocal or overt rehearsal. The former made few auditory confusions. Whereas white

noise had no effect on types of errors made or on over-all performance, it did bring in the open the usually covert rehearsal process, i.e., the Ss rehearsed audibly during the noise. Hintzman reasoned that Kinaesthetic feedback must have been present on both noise and non-noise trials "presumably produced by small, covert muscular responses in the vocal apparatus." This interpretation agreed with the theory that thinking involves "talking to oneself" without producing overt vocalizations.

Mackworth and Hintzman provided evidence above that visual STM depends on the speed and strategy of verbal encoding, whether by rote rehearsal or classification. Haber (1964) felt that the speed of encoding was in fact highly related to the strategy employed. He taught Ss to encode verbally, by means of one or two strategies, pairs of cards which differed in object numbers, colors and shapes. Encoding and rehearsing (for 20 seconds) was done orally on the assumption (similar to Mackworth's 1962) that silent and oral encoding and rehearsal, while not identical, were temporally similar processes. Haber found the two strategies - "objects code" and "dimensions code" - to differ as predicted on the speed of encoding and on the accuracy of encoding. Further, stimuli encoded more slowly contained more errors in recalls. The differences were explained as support to the hypothesis regarding encoding speed and interference during retention.

Haber (1965) further suggests that most visual stimuli are remembered by being encoded into previously learned linguistic

units, usually words. "This encoding takes place while the stimulus (or its brief short-term memory) is still present, and whatever has not been encoded after the stimulus has faded is entirely lost and not available in permanent memory." He adds, "This is not to deny that a few Ss may use some nonlinguistic code, especially for nonlinguistic stimuli. However, certainly with respect to the kinds of materials of greatest interest to psychologists, encoding into words is the most probably basic strategy."

In a study similar to Conrads but extended to investigate intrusion errors between all 26 letters of the alphabet and the digits 1 through 9, Wickelgren (1965) varied the method somewhat to exclude the possibility of perceptual errors. He had the Ss copy the list as it was presented, cover it from view and then recall what they could of the list. A detailed analysis of the sounds of intruded items supported conclusions agreeing in detail with Conrad's, that short-term storage of written language stimuli uses an auditory (or speech-motor) code. Wickelgren in his discussion does not rule out the possibility that visual-sensory or writing motor systems play some role in short-term memory, but adds that "no evidence available at present requires one to postulate any replication of short-term traces outside of the auditory or speech-motor systems."

One further piece of evidence toward a verbal component in visual STM is given by McKinney (1966) who demonstrated that a visual stimulus is "perceptually more stable" when recognized as

a familiar letter than the identical material when it is not associated with its verbal label. McKinney's study employed the defocusing technique in which Ss fixated a black dot on a slightly out-of-focus figure and reported whether or not any segment of the figure was seen to fragment or disappear.

Melton (1963) without adding any experiments of his own with respect to the processing of the visual trace, agrees that "there is a very short-term visual preperceptual trace which suffers rapid decay (complete in .3 to .5 sec) and that only that which is reacted to during the presentation of stimulus or during this post-exposure short-term trace is potentially retrievable from memory." Although Melton defines "reacted to" rather broadly - as "getting 'hooked up', associated, or encoded with central or peripheral response components" - he infers that verbal encoding is the chief perceptual process.

It is interesting that these verbal encoding theories developed from recent investigation and were not follow-up studies to defend the associationists in explaining the changes that take place in long-term retention of visual stimuli. It will be recalled that it was Gibson's conclusion (1929) that these changes were determined by "cues from a verbal analysis which was made of the forms during perception." and Carmichael, et al. (1932) who further demonstrated the influence on recall which words have when paired with the stimulus figures.

It must be noted, however, that the above authors' conclusions are all based upon experiments in which the stimulus material has been limited entirely to linguistic or easily classifiable units (digits and letters) and in which a linguistic or verbal response set, vocal or written, had been given the Ss.

Studies of essentially nonlinguistic visual STM

There are, admittedly, several kinds of so-called nonlinguistic stimuli, and all present methodological difficulties with respect to STM, such as finding an appropriate measure of the recall of that stimulus. It is also true that whereas a stimulus is initially nonlinguistic and difficult to name, given sufficient time at least some verbal encoding can take place with regard to any stimulus, the recall becoming (at least in part) that of an auditory code.

Several studies by Glanzer and Clark (1963, 1964) provide us with one methodological approach to the essentially nonlinguistic visual stimulus by using horizontal arrays of black and white figures (binary numbers) and conventional line drawings with recall being that of visual-motor reproductions (written "Bs" or "Ws"). They found that the most accurately reproduced patterns were those which required the shortest verbal description in accordance with descriptions written of the stimuli during 30-second stimulus presentations by another group of Ss. The authors not only agree in detail with the previously presented encoding theories based on linguistic units, but, paradoxically, allow no leeway for other forms of encoding: In offering what they designate the "verbal loop hypothesis"

they assign a key role to covert verbalization in the process of perception: "The hypothesis states that an S carries out a perceptual task in two stages: (1) he translates the input information into a series of words; (2) he holds the verbalization and makes his final response, e.g., reproduction on the basis of it."

By having the Ss begin their responses immediately following the visual presentation, well within the one to two-second post-exposure visual trace, Glanzer did not control for the portion of visual recall which was given directly to this trace, nor the portion given to the covert verbalization which was also permitted to take place as a response to this trace (which factor his hypothesis emphasizes). This writer agrees with Postman's observation (1963) that "since verbal mediators are frequently invoked to account for whatever systematic error tendencies are observed, control of interpolated activities becomes essential." Were Glanzer to prevent both of these verbal processes from occuring during stimulus presentation and the post-stimulus interval, according to his hypothesis he would expect a complete forgetting of the stimulus. But this test of his hypothesis was not run.

Discussion and alternate views

It is felt that a brief divergence is necessary at this point as there is a somewhat complicating or confusing factor regarding the term "perception".

Melton, Mackworth and Glanzer have all seemed to identify perception with the process of encoding, inferring that without

a coded memory trace there has been no perception of the stimulus. It is possible that these authors have joined forces with Bruner (1957) who proposed that perceptual experience is the result or end-product of categorization. They seem, however, to have restricted the meaning of "categorization" to that of a verbal code, whereas Bruner did not insist that categories be verbal.

The difficulty arises in that there is insufficient agreement among STM theorists regarding this term. Haber (1966) makes a clear distinction between reporting one's experience and reporting the attributes of stimuli that one remembers seeing. He states "One task is perceptual while the other deals with a memorial process. These must be conceptually differentiated, even if they may function similarly, and even if they proceed originally from the same sensory base." Haber adds, in adept expression of this writers impression, that, "There are innumerable experiments that fail to make this distinction, and much of the controversy among perceptual theories results directly from this confusion... To provide evidence relating to either or both of these requires that operational definitions be made for measurement of perceptual experience directly, or that deductions from these hypotheses specify operations in terms of memory alone that will still permit inferences concerning perceptual experience."

Neisser, in a comprehensive summary of STM principles (1967) feels that Bruner's idea of perception must be rejected and proposes (and uses) the term "iconic" for the transient visual sensory store

of stimuli which have been perceived but not necessarily categorized. He refers to the visual content as the "icon", prefering to avoid the word "image" because of its many other connotations.

Despite Melton's and Glanzer's inferences about perception as STM, several authors who argue for a nonverbal Gestalt-based perceptual event do not necessarily insist on a totally nonverbal memory storage. Garner and Clement (1963), for example, in commenting on Glanzer's hypothesis, indicate that they would not disagree with the hypothesis as long as it is used to explain accuracy of pattern reproduction, but argue that it does not constitute an explanation of "perceived pattern goodness". Neisser supports this in his statement (1967) that perceptual constancies operate before recognition, to make recognition possible, e.g., despite retinal projection changes, even unfamiliar objects tend usually to keep their shapes and sizes through transformations.[1]

Some perception studies, however, do provide evidence related to visual memory.

Furth (1963) questioned the need for verbalization in the perception of visual forms, and more specifically in the organization of percepts as represented by Gestalt principles. His tests

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[1] This thesis is interested in the process the stimulus or its trace must go through in order to be recalled at a later time. It does not matter if this is referred to as "perception" or not, however this paper will continue to use the terms "sensory store" or "iconic", "processed" or "encoded" in the place of "preperceptual" and "postperceptual".

involved the visual-motor recall of visual forms, although correctness of response was judged upon the merits of whether closure, proximity and other principles were either retained or aided in the identification of the form. His results indicated that age was a discriminating variable but that verbal experience was not, and he concluded that Gestalt principles develop relatively independently of language acquisition "without denying the influence of language."

In a somewhat more distantly related area Furth (1961) explored the influence of language on the development of concept formation in deaf children. He concluded from the study that the deaf persons superior performance on certain problems may be due to his less sophisticated approach to the situation, in which case the hearing persons greater store of available verbal mediators may be actually a hindrance. Furth did not comment on the degree of substitutive training any of his Ss may have had in the encoding of words or concepts.

Perhaps the most outspoken author in favor of a verbally nonencoded STM is Neisser (1967) who states that "It is impossible to suppose that all visual memory really stops with the icon; that we preserve nothing except what we have time to describe. One does not synthesize visual figures only for the sake of naming them." Neisser calls upon common sense in noting the everyday experience of animals and young children, as well as in dreams to prove his point, that "visual information can outlast the stimulus almost indefinitely." He also refers to laboratory studies, but purpose-

fully limits these to those involving stimulus recognition rather than reproduction.

It is tempting to use the evidence relating to so-called photographic or eidetic imagery as support of an unencoded memory of visual stimuli beyond the 2-second iconic stage. It is true, according to Haber and Haber (1964), that for at least 40 secs and as long as several minutes eidetiker children could still "see" the removed stimulus and read off details that they had not noticed earlier. The Habers' study was noteworthy in that they gave special attention to eye movements and found that these played an important role in eidetic imagery. Such eye movements compare similarly to the eye movements observed during the brief iconic stage of normal subjects in STM tests, in contrast to their absence in later recall periods.

Is eidetic imagery, then, a special case of sensory or iconic storage. The Habers found it to exist only in a discrete group (8%) of children from an urban population, even disappearing in these children by process of aging. Doob, (1964) on the other hand, found eidetic imagery to be common in illiterate <u>rural</u> Nigerian adults, but rare amongst <u>urban</u> members of the same tribe, suggesting an acculturation effect. It would appear that verbal training becomes incompatible with this special long term imagery, whether it be a direct physiological effect or a type of atrophy from disuse due to improved verbal coding efficiency.

Neisser notes that anecdotal evidence exists from several workers in the field that some persons can recreate an eidetic image "after months or years", but that there is no experimental information about this possibility. It would be of importance to this paper if there were experimental evidence to demonstrate even the accurate recreation of uncoded portions of the image only a few minutes following the disappearance of the first eidetic image.

There seems to be a real potential in using eidetic imagery studies to argue for uncoded visual STM, however its low frequency within the population makes obtaining Ss difficult.

Information from a different approach regarding mental processes comes from Davis (1956) who discussed six factorial studies of the Wechsler-Bellevue I and WAIS intelligence scales. All the studies identified g (sometimes referred to as the educative or general reasoning factor), a broad verbal factor (verbal comprehension), and a nonverbal, organization factor variously identified as performance, space and visual-motor organization.

Quoting Wechsler himself (1958); "It is certainly true that a good auditory memory does not go with a good visual memory. Persons who can repeat a poem after one hearing often have difficulty in reproducing a picture or a design, and great chess players who are known to have extraordinary powers of visualization have not shown unusual memory span for digits." Wechsler acknowledges, however, that the combination of the two tests which show the highest loadings on the memory factor (Digit Symbol and Digit Span) would seem to indicate that both modalities have something in common,

"perhaps a general or neutral memory function." He adds that, "It is a neutral memory of this sort which is apparently important in intelligence, particularly in later adulthood where it plays a substantial role."

Workers in the field of ability testing have devised a number of tests of "visual memory", some of these being the Benton Test of Visual Retention, Memory for Designs, and subtests in the recently developed Frostig and Illinois Test of Psycholinguistic Ability. Tests of visual retention for designs and forms are part of a standardized approach to the detection of neural dysfunction or brain damage.

Despite these numerous tests there is a total lack of controled studies which experimentally demonstrate the existence of visual memory in the absence of any verbal encoding. It is interesting to speculate that if verbal encoding is indeed the memory unit then such a visual test may in reality be a test of "verbal encoding ability for visual designs", as distinct from an auditory memory span. It might explain the correlation of Digit Symbol with Digit Span and eliminate the need for a "neutral memory". An explanation, however, would have to be given for the factor analyses which distinguish between a verbal and nonverbal component of mental functioning.

CHAPTER II

THE PROBLEM

It can be seen from the foregoing that there are two general opinions regarding the retention of visual stimuli beyond the iconic or sensory storage period; those on the one hand who hold to a verbal encoding theory of both perception and STM (e.g., Glanzer, Melton) and those on the other hand who state or allow for nonverbal processes (e.g.,Furth, Wicklegren, Haber and Haber, Neisser).

It is interesting that, despite the opinions and theories of these authors, practically no experiments have been performed in an effort to provide the proper controls on the variable in question, that is _verbal encoding_. Conclusions therefore regarding visual STM in general stated prior to such controls should be considered premature. Furth's studies using deaf children most closely approximates verbal control, but results were interpreted more in Gestalt fashion than in terms of STM.

It is this writer's impression that an appendage to the foregoing theories of verbal encoding might be that for visual STM beyond the short-lived sensory store, sufficiently simple nonlinguistic visual stimuli can be stored and retrieved from store (even in noneidetiker _S_s) by virtue of a purely visual perceptive encoding capacity, verbal encoding not being essential to its storage or retrieval, The point to clarify here is not that verbalization plays no part in post-iconic visual retention, but

that it is but one of several responses an individual can make to a visual image, such as Wicklegren's (1965) "visual-sensory or writing motor systems". It could not be assumed a priori that such a visual processing would have parameters similar to those of verbal encoding (for example, it is possible that spatial or Gestalt relationships rather than the specific presence or shape of lines are encoded). Or, as Neisser suggests, the visual percept may involve a genuine integration of successive retinal patterns, preserved as a "schematic visual object". However, to uncover these parameters would require a specific field of study in itself.

Neisser's summary also criticizes STM studies involving reproduction of the stimulus because of the possibilities that the response may also be based on such other sources as verbally-encoded information, stereotypes, or motor habits. However, instead of emphasizing techniques which control for the above, he restricts his interest to studies involving recognition rather than reproduction on the assumption that these other sources of information do not become involved in recognition. It is this author's preference to follow the traditional definition of STM which involves both the processes of storage and recall from storage, at the same time seeking a design which will control for adulterating factors, specifically, that of verbal encoding.

The present study

The purpose of this experiment is to demonstrate the existence of visual STM beyond the iconic store despite the absence of verbal encoding opportunity. The essentials of the design are as follows:

Two groups of Ss, one trained in verbal set, the other in visual set, were presented with complex, nonlinguistic visual stimuli of variable duration with the task being later to recall these stimuli graphically. Vocal interference activities on the part of S were enforced both prior to stimulus presentation, during stimulus presentation, and following its removal up to the point of recall, exceeding the maximum time interval given for iconic store. This encompassing verbal interference will be referred to as Para-Stimulus Interference, or PSI.

The stimulus which was found to satisfy the requirements of (a) simplicity in recording and scoring, yet (b), sufficiently complex to be essentially nonlinguistic, novel, and noncategorizable, was a single curved short heavy line laid in one of a predetermined number of ways against the background of a 2 by 2 grid, connecting one local vertex to another. (See Appendix for examples). Being spatial rather than shape oriented, the grid takes advantage of the fact that, for the curved line to be adequately verbalized, four factors must be taken into account: 1) the up-down (vertical) element, 2) the left-right (horizontal) element, 3) the degree of rotation of the line, and 4) the direction of the curve. On a single grid there are forty different alternatives. It was decided

that the stimuli for this experiment would be pairs of such grid units presented in block array, thus doubling to eight the number of factors to be retained in the memory. The probability of having both lines drawn correctly by chance is 1:1600.

Line positions were drawn at random except for adherence to the following conditions: (1) No two lines in the same pair were given identical positions, (2) The lines did not form a symmetrical pattern or design. There are no designs in the experimental literature which parallel the above PSI concept wherein S must vocally produce a speech message while (hypothetically) attempting to produce, subvocally, an encoded description of a visual stimulus.

Somewhat relevant experimentation is summarized by Broadbent (1962) in which he discussed the amount of information which can be handled by a listener when more than one message is presented to S simultaneously. One of Broadbent's conclusions was that performance is impaired when instructions are given which require the S to decode each message as well as write it down. This provides the basis for the assumption that there will be significant interference under PSI conditions, when S, in order to overcome the effects of PSI, must produce two messages simultaneously, one being an encoded response of nonlinguistic material. Should only one production be possible, external controls ensure that this will be the PSI activity. Broadbent's statement that interference is increased as a result of irrelevant material delivered both prior to and following relevant material lends one rationale for introducing the PSI activity prior to the stimulus presentation. This control further

ensures that the vocal apparatus will already be in active production of irrelevant material at the time of stimulus onset, leaving no unfilled period (brief as it might be) to initiate descriptive encoding.

As the longest estimated post-exposure visual trace period - iconic store - is about 2 secs (Mackworth, 1962) the time of recall will necessarily extend beyond 2 secs in order to demonstrate recall that is post-iconic. This post-stimulus duration was set at 3 secs plus the one to two secs required for S to pick up his pencil and begin recording his memory of the stimulus. PSI activities were also maintained during this post-stimulus 3-second period. It was expected that during this time they would interfere not only with a "read-out" from the iconic store but also with rehearsal of any verbal encoding that might have taken place from the point of stimulus onset.

Three types of verbal interference activities were selected:

1. Repeated recitation of a simple well-known nursery rhyme
2. Repetition of visually displayed descriptive words - similar to but contradicting the hypothetical verbal descriptions to be given the stimulus.
3. Backward counting by 3's in 3-digit numbers.

Broadbent again provides the reasons behind these choices. Descriptive words represent "unwanted speech similar in content to the wanted message", which, according to Broadbent, have a significantly interfering effect on recall of the "wanted" message. Probably the most interfering effect on an auditorally presented relevant message

is described by Broadbent as the simultaneous arrival of a second relevant message. If one considers a verbal problem-solving task, i.e., backward counting as a "second relevant message", it can be a basis for employing this task as a PSI activity. The paced backward counting technique as a means of preventing surreptitious repetition was introduced by Peterson and Peterson (1959) and is regarded by Melton as the "key to integration of retention data on immediate memory."

The nursery rhyme repetition as one form of PSI was retained for its simplicity, in being neither similar in content to the stimulus nor of a problem solving nature.

All PSI activities in this study were paced and of rather quick tempo, 2 beats per second, regulated by a metronome.

The present experiment was designed such that three sources of information would reach the S. According to the verbal encoding theorists, two of these are in the auditory channel - the PSI activity and the hypothesized encoding process. The third source of information is through the visual channel. The relevant information to be later recalled is provided only through the visual channel and through the hypothetical encoded message. According to Broadbent, presentation of the same relevant material simultaneously on different sensory channels results in one channel being discarded as a means of obtaining information. The hypothesis, therefore, of the present experiment is that with the concentrated effort at preventing subvocal verbalizing in the auditory channel, the probability of S using the preferred visual channel becomes extremely

high, and that despite the lack of opportunity for verbal encoding, there will yet be a stimulus recall significantly greater than chance.

The experiment was also designed to investigate the effects of (a) mental set - verbal and visual, (b) the various PSI activities compared with a noninterference condition, and (c) stimulus viewing time.

It was hypothesized that, under effective PSI conditions and nonlinguistic stimuli, recall scores achieved under verbal set would not be significantly different from those achieved under a visual set, due to a switch from a verbal to a visual means of processing.

It was also felt that stimulus duration (.5, 1, 2 or 4 secs) should be studied to determine the effect of viewing time on retention under the above conditions. Several studies (Mackworth, 1963, Smith and Carey, 1966, and Pylyshyn, 1965) suggest that recall performance will be improved with increased viewing time as a result both of encoding opportunity and rehearsal for the strengthening of these traces. In the present experiment, then, although it cannot be assumed _a priori_ that a form of visual process rehearsal during stimulus presentation cannot take place, one could be justified in questioning a verbal rehearsal should there not be a significant increase in scores with increased viewing time.

CHAPTER III

METHOD

A total of 48 Ss were used in this study, 26 male and 22 female, all enrolled in Introductory Psychology at the University of Alberta, Edmonton, and all participating in partial fulfillment of course laboratory requirements.

The experiment took place in a room which was shielded from external sources of light. A floor-to-ceiling partition containing an 8½ x 11-in translucent screen separated the S from E, and a chair and small table were provided for the S, facing the partition, such that his eyes were approximately 30 in. from the translucent screen, on a near horizontal plane.

On the table was placed a 6 page response pad, each page containing a double row of lightly drawn pairs of unmarked grids (See Appendix). It was the Ss task to correctly reproduce, on these grids, the two curved lines earlier committed to memory.

On the Es side of the partition was a Dunning Animatic 16-mm filmstrip projector and a connected tape reader which gave automatic control to the temporal duration of the filmstrip frames. Also governed by the tape reader was the operation of an electronic metronome which was adjusted to tick at two beats per second as a control on the pace of PSI activities.

A shielded 15 watt light bulb, placed just above the Ss table for the convenience of S in recording responses, was also controled

by the same tape reader. No light other than that thrown by the projector was used during stimulus presentation. The stimulus display was negative; that is, white figures were presented against a dark background. (From Mackworth's discovery 1963, that the duration of the visual image was independent of the luminance of the display and of the ratio of the display luminance to the intervening luminance, it was not felt necessary to control for screen luminance).

Provisions were made for the equipment to be operated manually during the period of instruction.

Procedure

The Ss were randomly assigned to two groups of 24 each. One group was given a pre-stimulus verbal response set; that is, the Ss practice describing a few examples on their own.

With the other group an attempt was made to provide a nonverbal, visual set wherein the stimuli were introduced simply as lines on a design which could be visualized and retained for later recall.

Except for the different stimulus instructions, all Ss underwent an identical experimental procedure.

The Ss were trained in four para-stimulus activities. In the first task the S was instructed to read aloud a three digit number which was shown on the screen, and immediately begin to count backwards by threes from this number in rhythm with the metronome ticking twice per second. Backward counting continued until the visual cue was given to stop.

The second task in which Ss were trained was that of repeating quickly, in response to the visual signal "recite", a nursery rhyme in quick cadence to the ticking metronome. The nursery rhyme was of the Ss choice, one he was quite familiar with, but chosen from a group preselected by E on the basis of their minimal number of pauses between syllable sounds. Those nursery rhymes preselected were:

1. Little Miss Muffet
2. Little Jack Horner
3. Old Mother Hubbard

S was to continue repeating the rhyme until the visual cue was given to stop.

In the third situation the S was to read aloud four descriptive words which were presented on the screen, and repeat these words, two per tick, until given the cue to stop. Such descriptive words were of the variety, "up, over, right, bottom, out ..."

The same group of four words was never repeated in succeeding trials of its type, and words were chosen on the basis that they did not describe properly any of the real spatial characteristics of the accompanying stimuli. This type of para-stimulus interference activity was introduced because of its similarity in structure to the anticipated attempt in verbal encoding of the stimulus.

The S is further introduced to a fourth situation wherein at a visual cue (an oblique cross) he was to undertake no verbal activity, but wait until the signal "recall", normally given to

terminate the previously mentioned activities.

The S was informed that during each of these various "tasks" the visual stimulus would appear on the screen for a short duration, and that as he would be tested later on his memory for the stimulus, he would have need to attend to it. However, he was not to interrupt the verbal activity in which he was presently engaged (if such was the case) until the visual cue "recall" was given. At that point he was to record on the special paper provided for him his memory of the stimulus lines. A brief summary of the instructions was again given for review and clarification of the purpose of the experiment.

The S was finally instructed to grasp a wooden rod (10 x 1½-in dia.), palms upward, with the back of the hands resting lightly on the desk, at all times during the experiment except to release one hand when necessary to record his response. This was introduced as a control against possible motor-kinesthetic or proprioceptive encoding. (Wicklegren, 1965)

Sixteen practice trials were given S, one for each type of PSI activity and stimulus duration. The S was corrected during these trials if in any way he deviated from the instructions (e.g., hesitating before beginning the verbal task, hesitating at any time prior to the signal to recall, failing to stop on signal or giving incorrect rhythm.)

Each item consisted of 6 frames on the filmstrip. An "attention" stimulus was first presented consisting of an arrow pointing to the

right, sitting toward the left of the screen. This remained in view for a 2-sec period, and was followed by a frame indicating task direction (a 3-digit number, an oblique cross, the word "recite", or a group of four descriptive words). This remained also for a fixed 2-sec period. The metronome was activated with the presentation of this task frame, and remained ticking until the recall period. A blank frame (black) filled the interval between the termination of the verbal task frame and the appearance of the visual stimulus, and was either two, three, or four secs, randomly preselected. The visual stimulus frame containing a pair of grids with short curved lines was then given a duration of either .5, 1, 2 or 4 secs. This was followed by another blank (black) frame of a fixed post-stimulus duration of 3 secs. The last frame in each series held the word "recall", and was shown noncommitant with the switching off of the metronome and the turning on of the light over Ss table. The S was allowed 8 secs to record his memory of the stimulus, following which the light was turned off and the "attention" frame was presented again, beginning a new series. Figure 1 presents a graphic picture of filmstrip presentation.

Trials were run in groups of 16. The type of para-stimulus activity and stimulus viewing time were each randomized systematically, so that each level appeared four times within every 16 items. Five trials were given for each type of interference activity at each level of stimulus duration, making a total of 80 items on which each S was tested, in addition to the 16 practice items (five filmstrips plus the practice strip).

Even as in nonsense syllables, it could not be assumed in this study that each stimulus display would be of equal difficulty despite precautions taken to rule out symmetry and identity. As a control against biased results due to stimulus difficulty effect, both of the response-set groups, composed of 24 Ss apiece, were divided into four groups of six Ss each. One group from each set was paired with a group of the other set, making up four counter balanced groups of twelve Ss each. Each of these counter balanced groups received in each filmstrip identical stimuli, in exactly the same order, but in each 16-item series the stimuli were paired systematically with a different type of PSI condition, so that no group received the same stimulus under the same condition as another group. The one exception to this was in the practice filmstrip, which was identical for all groups (see Table 1).

As an additional control for the possible interaction effect of stimulus difficulty, practice effect and order of presentation of filmstrip, the order of filmstrip presentation was randomized systematically within each counter balanced group; that is, each pair of Ss (one S from each "set") received a different order of the five filmstrips (see Table 2).

Following the experiment the Ss were given a short questionnaire to fill out (see Appendix C).

Detailed instructions given to the Ss are also found in Appendix D.

FIGURE 1

SHOWING ORDER OF FILMSTRIP PRESENTATION

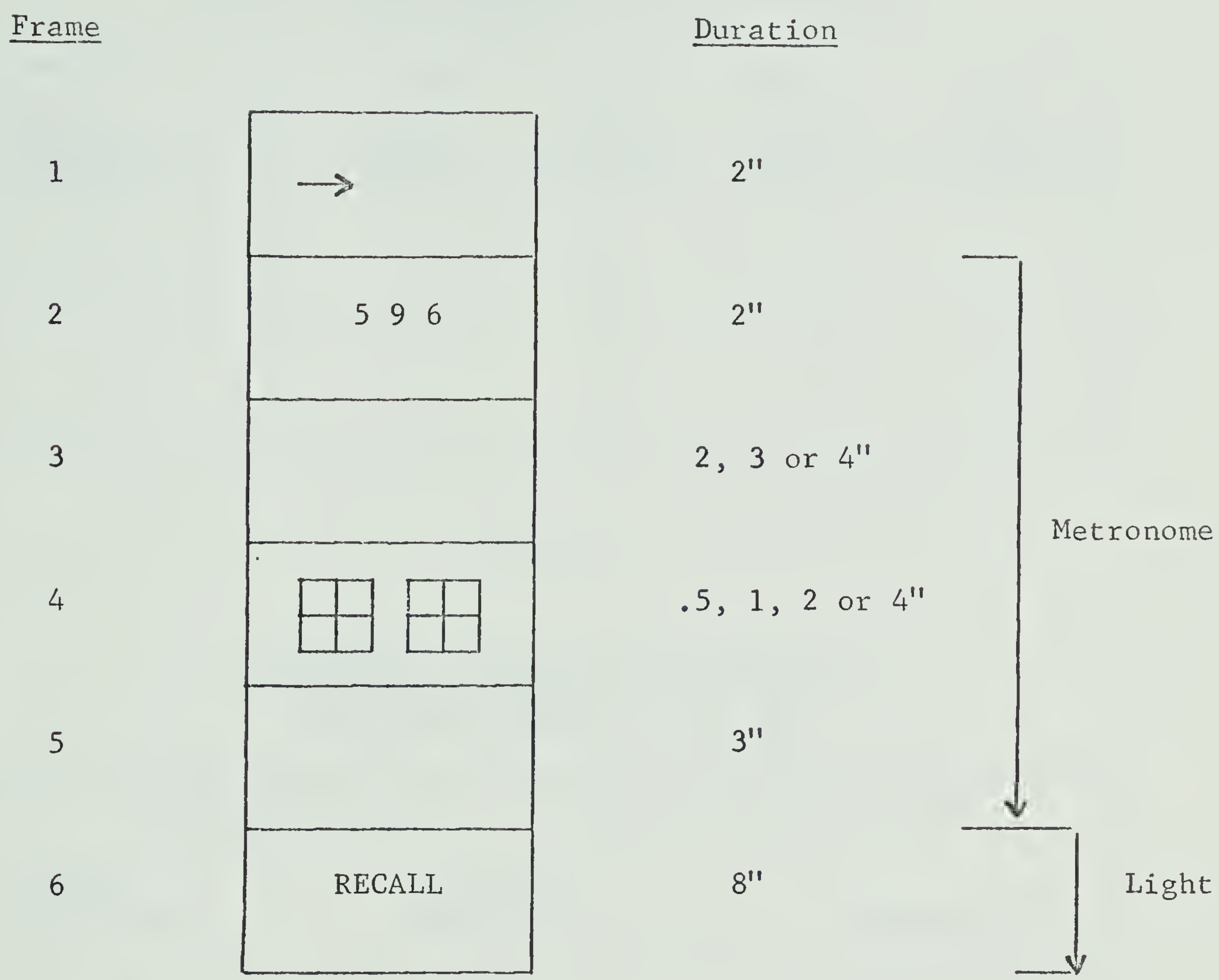

TABLE 1

SYSTEMATIC PAIRING OF A STIMULUS
WITH THE FOUR DIFFERENT PSI CONDITIONS
FOR EACH GROUP OF SS

Filmstrip X Stimulus	for Group A PSI (n)	for Group B PSI(n+1)	for Group C PSI(n+2)	for Group D PSI(n+3)
1	1	2	3	4
2	4	1	2	3
3	2	3	4	1
⋮	⋮	⋮	⋮	⋮
16	3	4	1	2

TABLE 2

COUNTERBALANCING OF MENTAL SET
AND ORDER OF FILMSTRIP PRESENTATION
WITHIN ONE SUBGROUP OF 12 SS

GROUP X - Stimuli x PSI(n) [or PSI(n+1) etc.]

Subject No.	Code	Filmstrip Order No.	Filmstrip No.
1	V1	(1)	p 1 2 3 4 5
2	N1		
3	V2	(2)	p 5 1 4 3 2
4	N2		
5	V3	(3)	p 2 4 1 5 3
6	N3		
7	V4	(4)	p 3 5 2 1 4
8	N4		
9	V5	(5)	p 4 3 5 2 1
10	N5		
11	V6	(6)	p 1 2 4 5 3
12	N6		

p = practice

CHAPTER IV

RESULTS

The main effect of PSI and mental set can be seen in Table 3 which shows the mean correct response for each PSI-set conditions summed over all stimulus exposure duration. It is notable that of the 20 trials the mean scores achieved by the 48 Ss even under the most interfering PSI conditions is significantly greater ($p < .01$) than that expected by chance (20 trials at 1:1600 probability).

It had been suggested earlier that a verbal mental set was a strong factor in determining what approach would be used in processing visual material, and was the cause for biased information leading to verbal encoding theories of STM. It was felt, however, that with sufficient verbal interference there would not be a significant difference between scores achieved by the verbal set and visual set groups. It can be seen in Table 3, contrary to predictions, that under each PSI condition the group trained in verbal set achieved higher scores than those trained in visual set.

It can also be seen that PSI used in addition to nonlinguistic stimuli did tend to make a difference in recall, and furthermore, that the greatest PSI effect on post-iconic recall resulted from condition No. 4, backward counting by 3's. Both of the other PSI condition showed poorer performance than the control (no PSI) although the impairment was rather minimal. Contrary to expectations, repetition or descriptive words (PSI No. 3) resulted in less inter-

TABLE 3

MEAN CORRECT RESPONSE, COMPARING VERBAL AND VISUAL SET IN EACH OF THE CONTROL AND THREE PSI CONDITIONS, SUMMED ACROSS EXPOSURE TIME

EXPERIMENTAL CONDITION	MENTAL SET	MEAN NO. CORRECT RESPONSES(/5)	DIFFERENCE BET. MEANS
Condition No. 1	Verbal	15.29	0.84
No PSI (Control)	Nonverbal	14.40	
PSI No. 2	Verbal	12.84	2.40
(Nursery Rhyme)	Nonverbal	10.44	
PSI No. 3	Verbal	13.36	1.24
(Descriptive Words)	Nonverbal	11.92	
PSI No. 4	Verbal	3.52	1.52
(Backward Counting)	Nonverbal	2.00	
Mean of PSI Conditions 2, 3 and 4	Verbal	9.92	1.80
	Nonverbal	8.12	

ference on stimulus recall than recitation of a nursery rhyme (PSI No. 2).

It is interesting to note that there was no selective effect (interactions) between of the PSI conditions and the mental sets, that is, no one kind of verbal interference activity had a significantly greater or lesser influence on verbal set in relation to visual set than the others. Whatever inhibited recall in the verbal set also inhibited recall in the visual set, to a slightly greater degree, their differences remaining rather stable.

Fig. 2 shows the mean number correct responses as a function of exposure time for the four different PSI conditions, for the visual and verbal groups separately. Overall, there is a very slight but significant improvement in performance with increased exposure time, the mean correct score of 20 trials for total Ss varying from 10.08 at .5 sec to 11.13 at 4 secs. With verbal and visual sets taken separately, however, the improvement did not reach significance. Results cannot be said to negate the possibility of a verbal rehearsal element though the evidence is slightly in the favor of such a conclusion.

Overall Analysis of Variance of these data can be found in Table 4. A more complete Analysis of Variance revealed that certain interactions within the counterbalanced conditions reached the level of significance. However, these were few, and because they presented an almost impossible task of interpretation in view of the variables involved, and also because the error term could not be found for

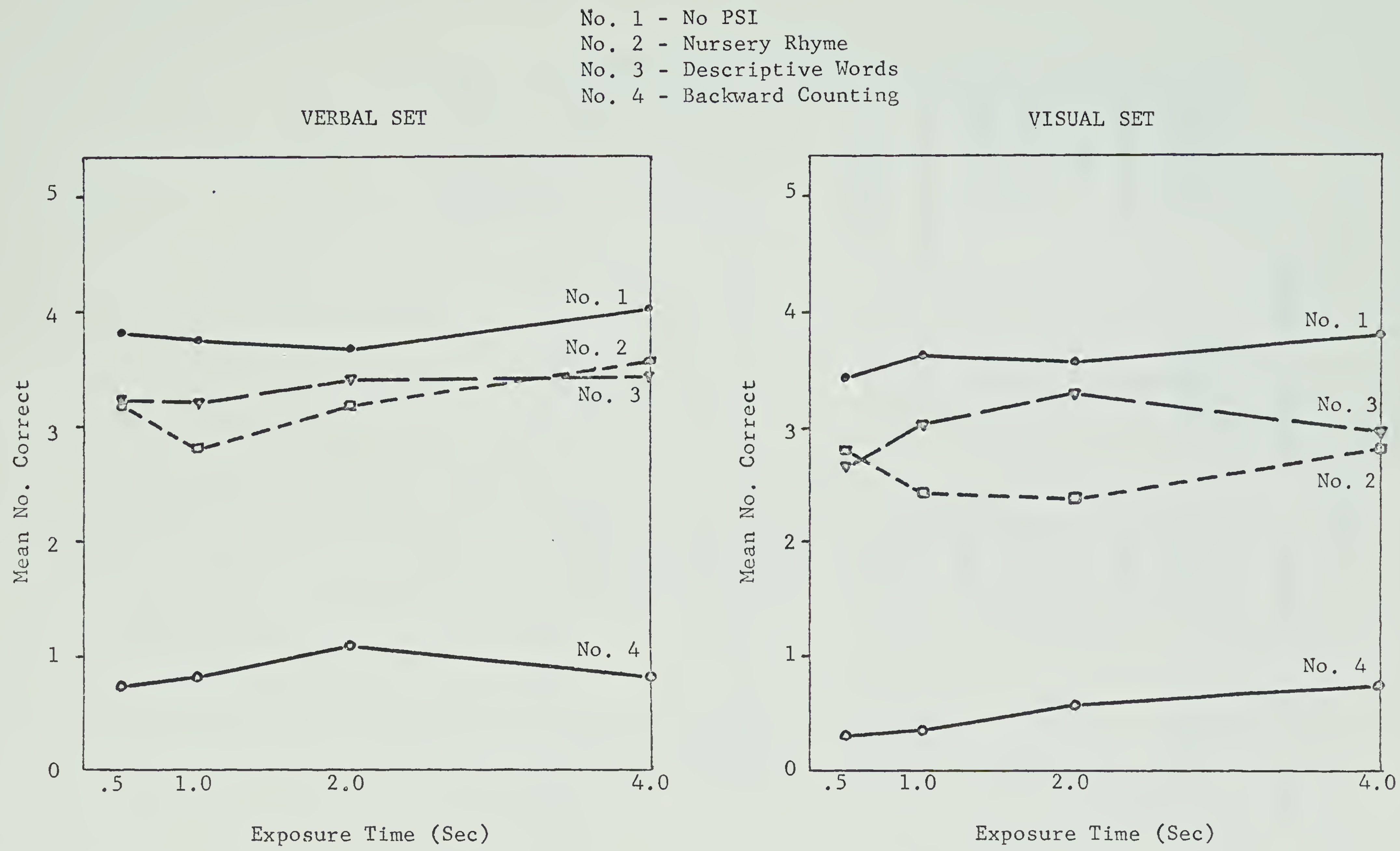

Fig. 2. Mean number correct responses as a function of exposure time for the four PSI conditions showing the verbal and visual groups separately.

TABLE 4

SUMMARY OF ANALYSIS OF VARIANCE OF STM SCORES

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between Ss	47	351.63		
V (Set)	1	28.91	28.91	4.12 *
Error (a)	46	322.72	7.02	
Within Ss	720	1710.07		
P (Para-stimulus	3	1016.46	338.21	351.02 **
T (Stimulus duration)	3	9.09	3.03	3.14 *
V x P	3	3.83	1.28	1.32
V x T	3	0.60	0.20	
P x T	9	10.03	1.11	1.16
P x T x V	9	5.23	0.58	
Error	690	664.83	0.96	

* - $p < .05$

** - $p < .01$

TABLE 5

DUNCANS NEW MULTIPLE RANGE TEST OF P (PSI CONDITIONS)

	(1) P_4 0.69	(2) P_2 2.91	(3) P_3 3.16	(4) P_1 3.71	(5) Shortest Significant Range (.01)
(1) 0.69		2.22	2.47	3.02	R_2 = 0.2581
(2) 2.91			0.25	0.80	R_3 = 0.2689
(3) 3.16				0.55	R_4 = 0.2763
	P_4	P_2	P_3	P_1	$S_{\bar{+}}$ = .07084

TABLE 6

DUNCANS NEW MULTIPLE RANGE TEST OF T (EXPOSURE TIME)

	(1) T_2 2.516	(2) T_1 2.521	(3) T_3 2.645	(4) T_4 2.781	(5) Shortest Significant Range(.05)
(1) 2.516		.005	0.129	0.265	R_2 = 0.1964
(2) 2.521			0.129	0.260	R_3 = 0.2067
(3) 2.645				0.136	R_4 = 0.2137
	T_2	T_1	T_3	T_4	$S_{\bar{+}}$ = 0.7084

several other variables, the different orders, groups and interaction variances were combined into the larger error term. All three main effects were significant, with the largest effect being accounted for by PSI treatment. No main interactions were significant. Tables 5 and 6 show Duncans New Multiple Range Test, for two of the main effects (Exposure duration and PSI activity). All of these results support the general picture appearing in Table 3 and described above.

What was the general effectiveness of nonlinguistic stimuli and para-stimulus verbal interference on covert or subvocal encoding?

In the instruction - training period, the Ss were observed to be very slow in verbalizing the spatial elements of the stimuli, or in Mackworth's terms, to "recognize and read off" these stimulus variables. As expected, there were typically pauses and halts during this process, with a number of Ss finding the task quite discomforting. According to the Ss responses to the post-test Questionnaire (Table 7) a good number of the verbal set Ss abandoned any verbal description approach and relied on other means, usually "visual", in remembering the stimulus. Of the verbally trained Ss only 4 attempted verbal encoding under both of the experimental conditions (PSI and nonPSI). Others (9) reportedly reserved verbal attempts only for noninterference conditions and an equal number tried the reverse, by reserving a visual form of encoding for noninterference conditions. Only 14 out of the 24 "verbal" Ss attempted to encode verbally under any of the conditions of the experiment.

TABLE 7

ENCODING APPROACH AS
REPORTED BY S FOLLOWING EXPERIMENT

	Number of "verbal" Ss (given verbal set instructions) n = 24		Number of "visual" Ss (given visual set instructions) n = 24	
	Reported Approach			
	Verbal	Nonv.	Verbal	Nonv.
Under para-stimulus interference	9	15	9	15
Under no interference	9	15	5	19 (χ^2 = 1.62 N.S.)
Under both conditions	4	10	3	12
Under either or both conditions	14	10	12	12

TABLE 8

MEANS AND STANDARD DEVIATION OF PSI SCORES
ACCORDING TO REPORTED MENTAL SET,
SUMMED ACROSS EXPOSURE TIME

		REPORTED SET			DUNCAN RANGE TEST[1] (Unequal ns) .05 level
		VISUAL	VERBAL P	VERBAL C	
	n	22	19	7	
Total Score	M	41.50	38.79	51.14	Vp V Vc
	SD	12.39	8.94	7.83	
PSI No. 1	M	15.09	13.58	17.30	Vp V Vc
	SD	3.25	3.82	1.49	
PSI No. 2	M	11.00	11.37	13.00	V Vp Vc
	SD	4.58	3.36	4.47	
PSI No. 3	M	12.65	11.58	15.57	Vp V Vc
	SD	3.55	3.08	2.24	
PSI No. 4	M	2.35	2.25	5.30	Vp V Vc
	SD	2.30	2.08	1.70	

Note: Verbal P includes Ss who reported partial verbal attempt only (either of the two conditions).

Verbal C includes Ss who reported complete verbal attempt (under both of the conditions).

[1]Details of Duncans Range Test are found in the Appendix.

Of interest is the almost equal number of Ss undergoing visual-set instructions who reported an attempt to encode the stimuli verbally. The fact that 9 Ss from each set reported a verbal approach to the nonlinguistic stimuli even under verbal interference raised the question as to what extent the stimuli were encoded. Further questioning of all the Ss revealed that at the most only three of the variables were able to receive any verbal treatment. These appeared to show little or no pattern, and would often consist of such verbalizations as "there", "this side" or a new quickly associated spatial meaning to one of the words being orally recited, (e.g., "lamb"). The rest of the spatial characteristics were reportedly left up to other nonverbal means. As a matter of interest, however, the scores of Ss were grouped according to their reported approach, and a comparison of their means and standard deviations is reported in Table 8. Results of Duncans Range Test are also shown.

Although there is no significant difference between means when partial attempts at verbal coding are compared with no attempts, there is a consistently higher mean recall score of those Ss who report verbal approaches in all rather than a part or none of the experimental conditions although this group is limited to 7 Ss. It appears then that the truly "verbal set" Ss, - those not greatly affected by PSI treatment - have in general a greater post-trace recall of the visual stimuli, although the larger group of Ss reporting a visual approach also achieved recall scores far exceeding that predicted by chance.

CHAPTER V

DISCUSSION

From the results it is seen that memory for nonlinguistic visual stimuli under the applied PSI conditions was significantly greater than chance in all Ss, whether verbally or visually oriented. It is also clear that it was of some import whether a nonlinguistic stimulus was used alone or was paired with PSI activity and furthermore that the type of PSI was crucial to the degree of post-iconic recall, paced backward counting by 3's having the greatest interference effect. Stimulus exposure time had very little effect on later memory for the stimulus.

The hypothesis that PSI would be successful in eliminating verbal encoding has limited support but demands some discussion.

It had been expected that the verbal-visual differences in mental set would indeed disappear under PSI, but that they would become rather pure visual-visual groups with negligible differences between recall (or even with less recall on the part of the "verbal" Ss who persisted in an unprofitable verbal set). Half of the verbal set group did in fact report a complete switch to a purely visual orientation, the remainder employing, apparently, a combination of the two approaches on a selective basis. However, self-reports of the visual group suggests that these Ss also modified their set, becoming almost identical in ratios to the mixed approach claimed by the verbal set. Instead of two resultant "visual" groups, according to self-report we ended up with two "visual and mixed" groups.

Was verbal encoding, then, really inhibited in the experiment? There was a significantly better overall recall by the verbally trained group. It is possible that the questionnaire responses are invalid themselves, the Ss being incapable of assessing objectively their memory and recall processes, and that the verbal set Ss did use the verbal encoding to a greater extent than they were aware.

However, an explanation of the superiority of the verbally trained group could lie in an uncontroled portion of the experimental procedure. It was realized post-experimentally, that Ss given verbal training received more than three times the amount of stimulus familiarization time than those who were given visual instructions, in having the former practice the encoding of several items. This familiarization bias, it is felt, could easily be responsible for the difference in scores, and in fact is consistant with the observation that verbal and visual sets tend to hold their relative positions without interaction with any of the experimental conditions. On the other hand, verbal reports indicated that Ss felt that they could indeed employ subvocal encoding while their vocal apparatus was being used in PSI activity, (some claiming simultaneous encoding; others an alternating process). And it is interesting to note that those Ss who claimed full verbal effort did tend to achieve better recall.

It should also be noted, however, that the score of Ss who reported a partial attempt at encoding was no better, in fact slightly poorer (although not significantly so), than those who said they

employed visual means only. The latter information does give some tentative support to prediction that scores of verbally set Ss might be equal to or lower than the visual group because of effective PSI.

It appears that it must also be accepted, however, that there are some Ss, in the ratio of about 7 out of 48 (14.5%), whose encoding attempts are not generally interfered with.

What caused so many of the visual trained Ss to attempt verbal encoding even to their occasional detriment? On the one hand it is not too surprising that university students, geared as they are to linguistic memory, should attempt to bring into play the equipment they are accustomed to working with. On the other hand, a portion of the explanation could lie in a subtle indoctrination or adulteration of the visual set groups which took place throughout the experiment. This came about through the introduction of descriptive words in PSI No. 3 which all "visual" Ss were forced to repeat aloud, giving them a form of verbal training, and very possibly a motivation to make the attempted switch.

If one could assume, hypothetically, a rather homogeneous group except for degree of initial familiarization, the results in Fig. 2 are still of interest in that the difference between scores from the PSI No. 1 (noninterference) and Nos. 2 and 3 of the PSI conditions, although significant, is of little magnitude suggesting either that the stimulus itself was substantially nonlinguistic and difficult to encode in itself - with the PSI conditions making little extra difference or that the PSI conditions were not really very interfering to the encoding process at all - that is, except for PSI No. 4.

What will account for the relatively extreme loss in stimulus recall in PSI No. 4 - backward counting by threes? On the one hand we might concur with Melton"s favorable appraisal of this Peterson and Peterson paradigm and assume it to be probably the really only satisfactory method of interfering with verbal encoding and rehearsal. On the other hand if we take cognizance of the questionnaire responses again it leaves the definite impression that the Ss found this task extremely difficult, frustrating and anxiety producing. Nearly all Ss admitted that in their efforts to calculate the decreasing 3-digit numbers they had to form visual images of the numbers in their minds, and as a result found it very difficult to even get an initial sensory image of the stimulus in its brief presentation on the screen. In the Peterson and Peterson study there was no similar interfered-with sensory impression of the stimulus letters because these were given aurally to the Ss prior to the counting task. In this experiment, what initially appeared to be a valuable auditory interference technique tended also to be a visual interference factor, acting both on the incoming sensory image and the subsequent visual processing, neither of which were intended to be interfered with. As the purpose of the experiment was to investigate the interference only of verbal encoding in visual STM, the result of PSI No. 4 would be considered questionable as a fair indicator of visual memory.

There is naturally a great deal of work to be done in discovering the ideal PSI task which selectively permits only a form of visual processing. The present study presents the results of only three, selected on their face validity. It is interesting that conditions

No. 2 and 3, being both a simple verbal repetition of a nonproblem solving nature, are so similar in their effect. Whether this type of PSI activity is the most effective or desireable remains yet to be seen.

The Ss often voiced the opinion that they could entertain subvocal thoughts in addition to their forced vocal productions. It is difficult to assess the validity of these opinions as in only a few of such self-report cases did this ability seem to help their recall substantially. On the basis of even these few cases, however, certain experimental and control measures should be reconsidered. In order to ensure a measure of external control over vocal activities the Ss were asked to repeat the PSI activities in a speech volume easily audible to the experimentor. In doing so it is possible that another very valuable interference factor was sacrificed. Broadbent noted (1962) that it was particularly hard to listen to one of two equally loud voices, but becomes easier when the relevant one is fainter. In our experiment the hypothesized relevant speech was assumed to be of a subvocal encoding nature and in fact, therefore, very much fainter than the vocal PSI. Ideally, the verbal interference would also be on a subvocal level. If this could be arranged without loss of external controls it would no doubt be a significant factor in the degree of confidence in assuming the reality of verbal interference. Would whispering have the same effect? or are there tasks of a problem solving nature which demand subvocal activity without necessitating visual imagery? Future designs could explore these.

Another form of interference which was neglected in this study was that employed by Conrad (1962) - white noise via earphones. We recall that it was white noise which forced many _S_s to bring into the open their otherwise subvocal processes. There can be little doubt this this additional control, used in conjunction with a proper PSI activity, would assure more total verbal interference.

CHAPTER VI

SUMMARY AND CONCLUSIONS

There is sufficient evidence from several sources that the visual image or icon lasts only a brief period - from .25 to about 2 secs following stimulus removal. Many authors state, from evidence at hand, that STM beyond the sensory image is dependent on a subvocal verbal encoding of the stimuli. The present study was conducted as an exploratory attempt to demonstrate successful inhibition of verbal coding and at the same time significant reproductive recall of complex visual stimuli.

Experimental design employed a nonlinguistic, noncategorizable stimulus and three conditions of systematic inhibition of verbal encoding and rehearsal, termed Para-stimulus interference (PSI). Conditions were constructed so as to create a maximal amount of verbal interference according to the principles discussed by Broadbent (1962). One group of Ss was trained to process the stimuli verbally (verbal set); a second group was encouraged to use visual means alone (visual set). Stimulus duration varied from .5 to 4 secs. It was hypothesized that PSI conditions would vary in their individual effectiveness, that the most interfering would cause an effective switch from verbal to visual means of encoding the stimulus, that there would be no significant difference between scores from the two differently trained groups, and that all scores would be significantly greater than chance expectations. A post-test questionnaire was also designed to reflect PSI effectiveness.

Results showed substantial recall for the stimuli despite interference measures taken, but appeared to be somewhat contradictory with regard to specific hypotheses. There was a significant difference between visual and verbal set groups favouring verbal training. However questionnaire results suggested almost identical encoding processes from both groups - not in the purely visual approach as expected but in a mixed and combined visual - partially verbal manner. Inadvertent verbal training of the visual set group through one of the PSI conditions was given as a possible determining factor for the verbal leaning, and it was also felt that a stimulus familiarization bias could account in part for the greater verbal set scores.

PSI conditions requiring only the use of vocal apparatus in simple recitation were found to further diminish the recall of the nonlinguistic stimuli to a minimal extent, whereas a problem-solving task, backward counting, severely impaired the recall of both mental set groups. This latter task was also found by report to interfere with visual as well as verbal encoding because of the required "visualizing" entailed therein, and therefore of questionable value in this type of experiment.

Increased viewing time to 4 secs brought only a slight improvement and was felt to be a reflexion of fairly effective verbal rehearsal interference conditions.

Where scores on the basis of self-reported mental set are used, a comparison of the visual vs. part-verbal groups shows no significant difference between these groups and lends support to the hypothesis that verbal encoding for these subjects was effectively interfered

with dispite the attempts made to encode in this manner. However, the superior mean scores of 7 Ss, who reported a more generally verbal approach, indicates that verbal interference measures were definitely limited in their effectiveness, at least for a portion of the population.

Although the evidence is not strong enough to permit conclusive statements about a completely nonverbal form of encoding, the present experiment does indicate the real possibility and presents an introduction to a new approach - through para-stimulus interference - in studying and further clarifying the parameters of a purely visual STM.

Future experiments should certainly seek to determine the most effective type of PSI, one which can interfere totally with verbal encoding without effecting visual processing. Controled whispering or subvocal speech in addition to white sound appear to be necessary additions for full interference to take place. A stimulus even more adapted to the nonlinguistic, noncategorizable, easy scoring requirements should also be given special attention. A crucial experiment might then be undertaken which compares such a stimulus to an equally difficult linguistic stimulus under effective PSI conditions, hypothesizing a significantly greater recall for the visual stimuli because of a recourse to nonverbal encoding.

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APPENDICES

APPENDIX A

STIMULI ACCORDING TO FILMSTRIP

APPENDIX A (continued)

No. 3 No. 4 No. 5

APPENDIX B

NAME SAMPLE RESPONSE SHEET

1 ______

2 ______

3 ______

4 ______

5 ______

6 ______

7 ______

8 ______

9 ______

10 ______

11 ______

12 ______

13 ______

14 ______

15 ______

16 ______

APPENDIX C

Code________________

QUESTIONNAIRE

(All information to be held strictly confidential)

Age________________________ Sex____________________________

Faculty_______________________________ Year________________

Average Mark in Grade 12________________

Best Subject in Grade 12________________Poorest______________

<u>Test Information</u>:

1. How did you feel during the experiment? (nervous, relaxed, anxious...)

   ____

   ____

2. What method did you use or attempt to use in remembering the placement of lines: (purely visual? verbal description? - other?)

   a - during verbal task:______________________________

   b - under no-task conditions:_________________________

3. Other comments:_______________________________________

APPENDIX D

INSTRUCTIONS TO SUBJECTS

(X) Indicates change of film
(T) Indicates switching on or off of ticker

Please seat yourself comfortably. You are about to undergo an experiment that will test your ability to think of two things at once. There has been a suggestion that students from different faculties and educational levels differ in their abilities to do this.

The experiment is fairly simple in operation. You will be shown a series of designs drawn similar to those on the form on the table in front of you, but with other lines on them, such as in this example. (X) It will be your job to try to draw the identical lines on your test form a short time after the design has been removed from view.

(Read only to Ss in Verbal set group)

FOR V GROUP - As you can see these lines can be described in a variety of ways. For example, the first one might be described as left of the center line, half way up, horizontal and curved upwards. The second one might be described as on the left side, in the lower half, slanted down and curved down. To speed up the description you might just say, flat, middle-left, up; slant, lower-left, down.

Here's another example (X) which might quickly be described as: slanted up, lower-right; curved down; and, slanted down, lower-left, curved up.

Now you try describing this example (X) aloud by yourself, to get a little practice at it.............That's fine. Another method, instead of using "up, left" or "up, right", would be to give the number of the quadrant that each line is in. The first line, for instance, is in quadrant 2, and the second is in number 1. How would you describe this stimulus (X) using the idea of quadrants?.........
...Fine.

FOR NV GROUP - Here are some other examples of what you will be shown (X)...... (2 sec) (X)......As you can see, you are quite capable of retaining a mental image of these lines just from looking at them carefully. You may recognize this one (X) from the beginning, still within your visual memory.

(Read only to Ss in Nonverbal visual set group)

This signal for you to draw in these lines on your paper will be this (X) "recall" sign, which will appear a few seconds after the stimulus design has disappeared. A little light will also turn on to help you see in recording the stimulus.

As a second part to this experiment you will be required to perform several different kinds of tasks, at special times. For one of these tasks whenever a 3-digit number appears on the screen, like this (X), you are to read the number aloud and immediately begin to count backwards from that number by 3's in rhythm to a ticking, which you will hear throughout most of the experiment, stopping only when the recall sign is shown. For example, if this were the number you would

say (T) 5 - 6 - 0, 5 - 5 - 7, 5 - 5 - 4, 5 - 5 - 1, and so on until stopped. Now you try this one (X) 6 - 3 - 1, 6 - 2 - 8, 6 - 2 - 5, 6 - 6 - 2 (X). That's fine! (Remember to give each number in rhythm to the ticking) (T).

It is during this backward counting that the stimulus design will appear on the screen for a short period. You are to pay close attention to this stimulus, for you will try to recall it later on, but you must not interrupt nor break off your counting until given the signal to do so, which is the same signal to recall the stimulus.

A second type of task you will engage in is that of reciting simple poetry. Of this (X) list of nursery rhymes, select one which you feel is most familiar to you............ Try it to be sure you know it.

It is at this (X) cue..."Recite", that you will begin immediately to recite "........." quickly, in cadence with the ticking you will hear, repeating the same verse over and over again if necessary until the given cue (X) to stop. Let's try one example, ready (T) (X) .... (1½ verses) (X) (Recall). That's fine (T).

Now a third type of activity: At the presentation of a group of words (X), Like this example, you are simply to read the words aloud quickly in time with the ticking, two words per tick, like this (T) "bottom out - up left, bottom out - up left, bottom out - up left. Now you try this one (X) ....(X) (T).

For the last type of activity, - a very easy one - At the sign of this (X) oblique cross you are required to say or do nothing at all, but just wait through the ticking until the cue to recall the stimulus, which you will have viewed at your pleasure.

Now for a quick review; your four different kinds of tasks will be either a number (X) which you will repeat and count backwards from by 3's, the (X) recitation of a nursery rhyme, the (X) reading and repeating of four words, and (X) saying nothing.

An arrow (X) will always precede your instruction stimulus, to both gain your attention and focus your gaze on the screen, for the task instruction will only appear for 2 secs before it is turned off again, and it will demand all of your attention to read it and begin the task; (X) (one second) (X). The visual stimulus will then appear, (X), briefly, (X), and in a few seconds the (X) Recall signal will appear, when you will stop whatever verbal activity you are engaged in and record your memory of the stimulus. The arrow will then come on again to prepare you for a new task and stimulus.

One further instruction: Please grasp the wooden rod, laying on the desk in front of you, with both hands, palms upward, with moderate pressure, and with the back of your hands resting lightly on the desk. You are required to hold this position at all times, during the experiment, except to release one hand when recording the stimulus, after which you are to resume the position. (Demonstrate if necessary).

Now we're ready for some practice trials. Place the first test form sheet in front of you and prepare for the first stimulus.

APPENDIX E

DUNCANS RANGE TEST OF REPORTED MENTAL SET

TOTAL SCORES

	(1) Vp(n=19) 38.79	(2) V(n=22) 41.50	(3) Vc(n=7) 51.14	Shortest Significant Ranges (Unequal n's) .01	.05
(1) 38.79		2.79	12.35	Rp(1+3) = 13.4	10.0
(2) 41.50			9.64	Rp(2+3) = 13.2	9.5

Vp V Vc

PSI NO. 1

	(1) Vp(n=19) 13.58	(2) V(n=22) 15.09	(3) Vc(n=7) 17.30	Shortest Significant Ranges (Unequal n's) .01	.05
(1) 13.58		1.51	3.72	Rp(1+3) = 3.91	3.24
(2) 15.09			2.21	Rp(1+2) = 2.66	2.00
				Rp(2+3) = 3.72	2.81

Vp V Vc

PSI NO. 2

	(1) V(n=22) 11.00	(2) Vp(n=19) 11.37	(3) Vc(n=7) 13.00	Shortest Significant Ranges (Unequal n's) .01	.05
(1) 11.00		0.37	2.00	Rp(1+3) = 4.91	3.81
(2) 11.37			1.63		

V Vp Vc

APPENDIX E (continued)

DUNCANS RANGE TEST OF REPORTED MENTAL SET

PSI NO. 3

	(1) Vp(n=19) 11.58	(2) V(n=22) 12.65	(3) Vc(n=7) 15.57	Shortest Significant Ranges (Unequal n's) .01	.05
(1) 11.58		1.07	3.99	Rp(1+3) = 4.08	3.10
(2) 12.65			2.92	Rp(2+3) =	2.93

Vp V Vc

PSI NO. 4

	(1) Vp(n=19) 2.25	(2) V(n=22) 2.35	(3) Vc(n=7) 5.30	Shortest Significant Ranges (Unequal n's) .01	.05
(1) 2.25		.10	3.05	Rp(1+3) = 3.01	
(2) 2.35			2.95	Rp(2+3) = 2.89	

Vp V Vc

APPENDIX F

STM SCORES FOR GROUP A UNDER EACH EXPERIMENTAL CONDITION

S Code	Total		Tried Verbal		Film Strip Number					Film Strip Order					Nothing				
S Gr.Or.	Score	Sex	PSI	Cntl	1	2	3	4	5	1	2	3	4	5	.5	1	2	4	Σ
V A 1	41	F	0	1	7	10	7	9	8	7	10	7	9	8	5	3	3	2	13
N A 1	47	F	1	0	10	8	10	9	10	10	8	10	9	10	4	4	4	4	16
V A 2	56	F	0	0	9	11	11	13	12	11	12	13	11	9	5	5	5	4	19
N A 2	40	M	0	0	12	6	8	10	4	6	4	10	8	12	4	3	4	5	16
V A 3	53	M	1	1	12	12	10	10	9	10	12	9	12	10	5	5	4	5	19
N A 3	16	F	0	0	3	4	2	5	2	2	3	2	4	5	3	1	0	4	8
V A 4	45	F	1	0	8	12	11	5	9	5	11	8	9	12	5	5	4	4	18
N A 4	26	M	1	0	2	8	1	7	8	7	1	2	8	8	4	3	4	2	13
V A 5	33	F	(1)	0	9	7	8	5	4	4	5	7	9	8	3	2	1	4	10
N A 5	41	F	0	0	9	11	12	6	3	3	6	11	9	12	4	4	4	3	15
V A 6	26	M	0	1	7	5	5	5	4	7	5	4	5	5	1	2	2	4	9
N A 6	45	M	0	1	8	12	10	9	6	8	12	6	10	9	4	5	3	4	16
Σ	469	7F	5	4	96	106	95	93	79	80	89	89	103	108	47	42	38	45	172
$\bar{X}$	39.08	5M			8.00	8.83	7.92	7.75	6.67	6.67	7.42	7.42	8.58	9.00	3.92	3.50	3.16	3.75	14.33

S Code	Recite					Words					Counting					Expos. Totals			
S Gr.Or.	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4
V A 1	3	3	5	3	14	3	2	4	2	11	0	0	2	1	3	11	8	14	8
N A 1	2	4	4	3	13	3	5	5	3	16	0	1	0	1	2	9	14	13	11
V A 2	4	4	3	5	16	3	4	5	4	16	1	1	2	1	5	13	14	15	14
N A 2	2	2	4	3	11	2	3	4	4	13	0	0	0	0	0	8	8	12	12
V A 3	3	2	5	3	13	4	4	3	4	15	0	2	3	1	6	12	13	15	13
N A 3	1	0	0	2	3	1	0	4	0	5	0	0	0	0	0	5	1	4	6
V A 4	2	2	3	4	11	4	4	2	3	13	0	1	1	1	3	11	12	10	12
N A 4	1	0	1	1	3	1	3	3	2	9	0	0	1	0	1	6	6	9	5
V A 5	2	5	1	2	10	1	4	4	2	11	0	0	0	2	2	6	11	6	10
N A 5	2	3	4	4	13	2	3	4	3	12	1	0	0	0	1	9	10	12	10
V A 6	2	1	2	3	8	2	0	2	3	7	0	1	1	0	2	5	4	7	10
N A 6	4	3	4	3	14	2	2	5	4	13	0	0	1	1	2	10	10	13	12
Σ	28	29	36	36	129	28	34	45	34	141	2	6	11	8	27	105	111	130	123
$\bar{X}$	2.33	2.41	3.00	3.00	10.83	2.33	2.83	3.75	2.83	11.75	0.16	0.50	0.92	0.67	2.25	8.75	9.25	10.83	10.25

APPENDIX F (continued)

STM SCORES FOR GROUP B UNDER EACH EXPERIMENTAL CONDITION

S Code	Total		Tried Verbal		Film Strip Number					Film Strip Order					Nothing				
S Gr.Or.	Score	Sex	PSI	Cntl	1	2	3	4	5	1	2	3	4	5	.5	1	2	4	Σ
V B 1	50	M	0	1	12	11	11	11	6	12	11	11	11	6	4	4	5	5	18
N B 1	37	M	0	0	6	4	10	8	9	6	4	10	8	9	5	4	4	4	17
V B 2	58	M	0	0	11	12	11	13	11	12	11	13	11	11	5	4	4	5	18
N B 2	38	F	0	0	6	6	8	7	11	6	11	7	8	6	2	4	3	5	14
V B 3	39	M	1	1	11	9	6	6	7	6	11	7	9	6	5	5	2	5	17
N B 3	31	M	0	0	4	7	5	10	7	5	4	5	7	10	3	3	2	3	11
V B 4	45	F	0	0	6	11	9	7	12	7	9	6	12	11	4	2	4	3	13
N B 4	36	F	1	0	6	9	7	5	9	5	7	6	9	9	2	3	4	4	13
V B 5	56	F	0	0	11	10	12	12	11	11	12	10	11	12	4	5	5	5	19
N B 5	38	F	1	0	6	9	9	5	9	9	5	9	6	9	3	3	2	4	12
V B 6	30	M	0	0	5	8	6	6	5	5	8	5	6	6	2	1	3	4	10
N B 6	27	F	0	0	2	3	6	10	6	2	3	6	6	10	3	3	3	3	12
Σ	485	6F	3	2	86	99	100	100	103	86	96	95	104	105	42	41	41	50	174
$\bar{x}$	40.42	6M			7.16	8.25	8.33	8.33	8.58	7.17	8.00	7.92	8.67	8.75	3.50	3.42	3.42	4.17	14.5

S Code	Recite					Words					Counting					Expos. Totals			
S Gr.Or.	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4
V B 1	5	3	3	4	15	4	4	3	4	15	1	1	0	0	2	14	12	11	13
N B 1	1	3	2	2	8	3	2	2	4	11	0	0	0	1	1	9	9	8	11
V B 2	5	4	4	5	18	5	5	4	4	18	1	0	2	1	4	16	13	14	15
N B 2	2	5	4	3	14	2	4	1	3	10	0	0	0	0	0	6	13	8	11
V B 3	1	1	1	2	5	3	5	3	4	15	2	0	0	0	2	11	11	6	11
N B 3	2	1	0	3	6	5	3	1	2	11	0	1	1	1	3	10	8	4	9
V B 4	5	3	3	4	15	4	3	5	4	16	0	0	0	1	1	13	8	12	12
N B 4	3	2	3	4	12	2	4	1	1	8	0	1	1	1	3	7	10	9	10
V B 5	4	4	4	5	17	5	3	4	5	17	0	1	1	1	3	13	13	14	16
N B 5	5	4	1	2	12	3	5	2	4	14	0	0	0	0	0	11	12	5	10
V B 6	1	1	2	2	6	1	1	3	5	10	0	1	1	2	4	4	4	9	13
N B 6	3	1	0	2	6	0	3	3	2	8	0	0	0	1	1	6	7	6	8
Σ	37	32	27	38	134	37	42	32	42	153	4	5	6	9	24	120	120	106	139
$\bar{x}$	3.08	2.67	2.25	3.17	11.17	3.08	3.50	2.67	3.50	12.75	0.33	0.42	0.50	0.75	2.00	10.00	10.00	8.83	11.58

APPENDIX F (continued)

STM SCORES FOR GROUP C UNDER EACH EXPERIMENTAL CONDITION

S Code	Total		Tried Verbal		Film Strip Number					Film Strip Order					Nothing				
S Gr.Or.	Score	Sex	PSI	Cntl	1	2	3	4	5	1	2	3	4	5	.5	1	2	4	Σ
V C 1	47	M	0	0	6	7	11	11	12	6	7	11	11	12	3	3	4	4	14
N C 1	54	M	0	0	9	13	13	9	10	9	13	13	9	10	5	4	5	5	19
V C 2	33	F	0	0	9	3	8	8	5	3	5	8	8	9	2	2	3	3	10
N C 2	52	M	0	0	11	11	13	9	8	11	8	9	13	11	2	4	5	5	16
V C 3	37	M	0	1	8	10	2	11	6	2	8	6	10	11	4	5	3	3	15
N C 3	43	M	1	0	5	11	7	13	7	7	5	7	11	13	4	4	3	3	14
V C 4	65	F	1	1	12	14	13	14	12	14	13	12	12	14	4	5	5	5	19
N C 4	28	M	1	0	7	9	4	2	6	2	4	7	6	9	1	3	3	2	9
V C 5	41	F	1	0	9	11	9	7	5	5	7	11	9	9	2	3	2	2	9
N C 5	34	F	0	1	6	6	9	6	7	7	6	6	6	9	5	3	3	4	15
V C 6	44	M	0	0	7	9	9	9	10	7	9	10	9	9	4	3	5	5	17
N C 6	45	M	0	0	8	10	10	11	6	8	10	6	10	11	3	4	5	4	16
Σ	523	4F	4	3	97	114	108	110	94	81	95	106	114	127	39	43	46	45	173
$\bar{x}$	43.58	8M			8.07	9.50	9.00	9.17	7.83	6.75	7.92	8.83	9.50	1058	3.25	3.58	3.83	3.75	14.42

S Code	Recite					Words					Counting					Expos. Totals			
S Gr.Or.	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4
V C 1	5	2	3	5	15	3	5	3	3	14	1	2	1	0	4	12	12	11	12
N C 1	5	2	3	4	14	4	3	4	5	16	1	1	1	2	5	15	10	13	16
V C 2	1	4	3	0	8	3	3	3	4	13	1	0	1	0	2	7	9	10	7
N C 2	4	2	4	3	13	4	5	4	5	18	1	1	2	1	5	11	12	15	14
V C 3	3	1	3	3	10	3	2	3	2	10	0	0	1	1	2	10	8	10	9
N C 3	2	2	3	3	10	2	3	4	5	14	1	1	0	3	5	9	10	10	14
V C 4	5	4	5	5	19	5	5	5	5	20	1	1	3	2	7	15	15	18	17
N C 4	3	2	0	4	9	3	2	2	3	10	0	0	0	0	0	7	7	5	9
V C 5	3	3	5	4	15	4	3	4	5	16	1	0	0	0	1	10	9	11	11
N C 5	2	2	1	3	8	2	5	2	1	10	0	0	1	0	1	9	10	7	8
V C 6	3	3	3	3	12	3	3	4	2	12	1	1	1	0	3	11	10	13	10
N C 6	5	4	4	4	17	3	1	3	4	11	0	0	0	1	1	11	9	12	13
Σ	41	31	37	41	150	39	40	41	44	164	8	7	11	10	36	127	121	135	140
$\bar{x}$	3.42	2.58	3.08	3.42	12.50	3.25	3.33	3.42	3.67	13.67	0.75	0.58	0.92	0.83	3.00	10.58	10.08	11.25	11.67

APPENDIX F (continued)

STM SCORES FOR GROUP D UNDER EACH EXPERIMENTAL CONDITION

S Code	Total		Tried Verbal		Film Strip Number					Film Strip Order					Nothing				
S GrOr.	Score	Sex	PSI	Cntl	1	2	3	4	5	1	2	3	4	5	.5	1	2	4	Σ
V D 1	64	M	0	0	10	15	13	12	14	10	15	13	12	14	5	5	5	5	20
N D 1	48	M	1	1	9	9	11	9	10	9	9	11	9	10	4	5	4	5	18
V D 2	34	F	0	0	8	6	9	7	4	6	4	7	8	9	4	4	4	4	16
N D 2	40	F	0	0	11	3	9	8	9	3	9	8	11	9	5	5	4	4	18
V D 3	58	M	1	0	12	12	12	11	11	12	12	11	12	11	4	5	5	5	19
N D 3	48	F	1	1	9	9	7	13	10	7	9	10	9	13	3	5	5	2	15
V D 4	25	M	0	1	6	9	3	5	2	5	3	6	2	9	3	3	2	2	10
N D 4	26	M	0	0	6	5	5	4	6	4	5	6	6	5	4	3	3	5	15
V D 5	47	M	1	0	10	8	10	8	11	11	8	8	10	10	4	5	4	5	18
N D 5	37	F	0	1	10	8	7	7	5	5	7	8	10	7	1	3	4	3	11
V D 6	52	M	1	1	12	11	11	9	9	12	11	9	9	11	4	4	4	4	16
N D 6	53	F	1	1	9	10	11	13	10	9	10	10	11	13	4	4	5	4	17
Σ	532	5F	6	6	112	105	108	106	101	93	102	107	109	121	45	51	49	48	193
$\bar{X}$	44.33	7M			9.33	8.75	9.00	8.83	8.42	7.75	8.50	8.92	9.08	10.08	3.75	4.25	4.08	4.00	16.08

S Code	Recite					Words					Counting					Expos. Totals			
S GrOr.	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4	Σ	.5	1	2	4
V D 1	5	3	5	4	17	5	5	4	4	18	3	1	2	3	9	18	14	16	16
N D 1	3	4	2	1	10	3	4	3	3	13	2	0	2	3	7	12	13	11	12
V D 2	3	1	2	4	10	1	3	3	1	8	0	0	0	0	0	8	8	9	9
N D 2	1	4	1	4	10	3	3	4	2	12	0	0	0	0	0	9	12	9	10
V D 3	5	3	5	4	17	5	3	4	4	16	2	2	1	1	6	16	13	15	14
N D 3	5	2	4	3	14	5	2	4	3	14	1	2	1	1	5	14	11	14	9
V D 4	1	3	2	4	10	2	0	1	2	5	0	0	0	0	0	6	6	5	8
N D 4	0	1	0	1	2	2	2	4	1	9	0	0	0	0	0	6	6	7	7
V D 5	2	3	2	4	11	2	3	2	3	10	1	3	3	1	8	9	14	11	13
N D 5	5	3	4	2	14	3	1	5	3	12	0	0	0	0	0	9	7	13	8
V D 6	4	5	3	4	16	3	4	4	4	15	2	2	0	1	5	13	15	11	13
N D 6	4	2	4	4	14	3	5	5	4	17	1	1	2	1	5	12	12	16	13
Σ	38	34	34	39	145	37	35	43	34	149	12	11	11	11	45	132	131	137	132
$\bar{X}$	3.17	2.83	2.83	3.25	12.08	3.08	2.92	3.58	2.83	12.42	1.00	0.92	0.82	0.92	3.75	11.00	10.92	11.42	11.00

APPENDIX F (continued)

STM SCORES FOR ALL GROUPS UNDER EACH EXPERIMENTAL CONDITION

	Total Score	Sex	Tried Verbal PSI	Cntl	Film Strip Number 1	2	3	4	5	Film Strip Order 1	2	3	4	5	Nothing .5	1	2	4	Σ
Σ	2009	22F	18	15	391	426	411	409	377	340	382	397	430	461	173	177	174	188	712
$\bar{x}$	41.85	26M			8.15	8.83	8.56	8.52	7.88	7.08	7.96	8.29	8.96	9.60	3.60	3.69	3.63	3.91	14.83

	Recite .5	1	2	4	Σ	Words .5	1	2	4	Σ	Counting .5	1	2	4	Σ	Expos. Totals .5	1	2	4
Σ	144	126	134	154	558	141	151	161	154	607	26	29	39	38	132	484	483	508	534
$\bar{x}$	3.00	2.63	2.79	3.21	11.65	2.92	3.15	3.35	3.21	12.65	0.54	0.60	0.81	0.79	2.75	10.08	10.06	10.58	11.13